Low Birth Weight as a Risk Factor for Gestational Diabetes, Diabetes, and Impaired Glucose Tolerance During Pregnancy

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Small size at birth as a risk factor for the development of diabetes or other metabolic disorders has been described in numerous populations over the past 2 decades (1–12). Most studies dealing with children or nonpregnant adults have reported an inverse linear relationship between birth size and the prevalence of disease (1–4,6–10), but the relationship among the Pima Indians from Arizona has been described as "U-shaped" because the high risk is seen in individuals with high birth weight as well as low birth weight (5). Several reasons for this relationship have been proposed (13) and a similar finding was subsequently reported among schoolchildren in Taiwan (11). Since the 4th International Workshop-Conference on Gestational Diabetes Mellitus, where the association between a woman's birth weight and gestational diabetes mellitus (GDM) or pregestational diabetes was first presented (14), there have been several similar reports in the literature. The purpose of this article is to review some of the recently published data on this relationship, which is well described in the general population but still less studied among pregnant women.

FINDINGS — Table 1 presents results of studies presenting data on a woman's birth weight as a risk factor for GDM (14–21). Several of the studies are population studies that present the prevalence of GDM by birth weight (14–18), whereas others present the birth weight frequency distributions of women with and without GDM (19,20). These studies all found that the prevalence of GDM was higher in women who were in the lower birth weight category or categories. A significant relationship between a low birth weight and gestational or pregestational diabetes has been described among Native American women in Arizona and Washington State, among African-Americans and Hispanics in Washington and New York State, and among non-Hispanic whites from Washington, New York, Norway, Italy, Australia, and Malta (14–21). Interestingly, several studies (15–17,19), in addition to the Pima study (14), described a U-shaped association between birth weight and GDM (Fig. 1). The article by Moses et al. (21) reports, among women with GDM, that the mean 2-h glucose concentration at the diagnosis of GDM is associated with that woman's birth size. Women who had been small for gestational age at birth had a 2-h glucose concentration that was significantly higher than women who had been of normal weight for gestational age (21). There was a tendency for women who had been large for dates to have a higher glucose as well, suggesting a U-shaped association, but this difference was not significant.

DISCUSSION — With the large number of reports in nonpregnant populations that low birth weight is a risk factor for the later development of diabetes at young ages, it was to be expected that it might also be a risk factor for GDM. As shown in this article, this has been a common finding, and several studies, some of them with very large sample sizes, have provided confirmation. Of interest is that several reported a U-shaped association with birth weight—a finding that has been uncommon in nonpregnant populations. These studies, the Pima Indian study, and the Taiwanese schoolchildren survey all share a young age of onset of diabetes. For decades, the Pima Indians have developed diabetes at relatively young ages (22). Today, type 2 diabetes is being found increasingly in younger members of other populations as well (23). GDM, since it is a condition of women of childbearing age, also develops at a relatively young age. One reason may be that for young people today, a large birth weight was more likely due to an abnormality during pregnancy, such as maternal diabetes in the case of the Pima Indians (5,22), that puts them at high risk for developing diabetes in contrast to the past when a large birth weight was more likely associated with overall general health of the mother and child and therefore was not a risk factor. The future may prove that this finding becomes more common in the general population over time. In particular, additional surveys similar to the Taiwanese study that relate childhood-onset type 2 diabetes to birth weight should be undertaken to provide more insight into this question.

SIGNIFICANCE FOR PREGNANCY SURVEILLANCE — Universal screening for GDM was the recommendation of the American Diabetes Association from 1979 (24) until 1998 (25). The participants at the 4th International Workshop-Conference on Gestational Diabetes recommend that women who met certain characteristics (member of low-risk ethnic group, no known diabetes in first-degree relatives, age <25 years, normal weight, no history of abnormal glucose tolerance, and no history of poor obstetric outcomes) did not have to be screened routinely (25). Although this recommendation has not been universally accepted (26–31), for those who do follow these guidelines, a normal

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Abbreviations: GDM, gestational diabetes mellitus.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.
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Table 1—*Studies reporting GDM in relation to a woman's own birth weight*

Author	Population/location	Sample size	Presentation	Findings
Pettitt and Knowler (14)	Pima Indians		Prevalence by birth weight	U-shaped association of diabetes prevalence
	Age 15–24 years	573		15- to 24-year-old group, highest rate in birth weight ≥4.5 kg
	Age 25–34 years	258		25- to 34-year-old group, highest rate in birth weight <2.5 kg
Williams et al. (15)	Washington State	41,839	Prevalence by birth weight	
	Non-Hispanic white	21,528		Linear inverse relationship
	African-American	6,359		U-shaped—significantly higher at <2,000 and ≥4,000 g
	Native American	7,456		Linear inverse
	Hispanic	6,496		Linear from <2,000–3,000 g, flat above 3,000 g
Egeland et al. (16)	Norway: birth registry	138,714	Prevalence by birth weight	U-shaped—significantly higher at <2,500 g
Innes et al. (17)	New York State Birth Registry 1994–1998	23,314	Prevalence by birth weight	U-shaped—significant linear inverse trend from <2,000–4,000 g; ≥4,000 g significantly higher
Seghieri et al. (18)	Pistoia, Italy: women with positive 50-g screen	604	Prevalence by birth weight	Significantly higher at birth weight <2,600 g; unrelated at higher birth weights
Savona-Ventura and Chircop (19)	Malta	324 with GDM	Frequency distribution of birth weight	Birth weight distribution significantly different from that of the general population; higher at 1,000–2,000 g (risk ratio = 2.8) and at ≥4,500 g (risk ratio = 2.7)
Bo et al. (20)	Torino, Italy	50 with IGT; 50 with GDM; 200 normal	Frequency distribution of birth weight	Birth weight distribution among IGT/GDM significantly different from normal; linear inverse among IGT/GDM, flat across quartiles among women with normal OGTT
Moses et al. (21)	Australia	138 with GDM	2-h glucose by birth size	SGA women with GDM had higher 2-h glucose

IGT, impaired glucose tolerance; SGA, small for gestational age.

birth weight should be included in the list of characteristics a woman must possess to be exempt from routine screening.

In summary, women from diverse populations who were of low birth weight are at risk for the development of GDM. This observation is not surprising given the well-described health consequences of abnormal fetal growth that are apparent in very young children and persist into adulthood. Unlike the preponderance of reports among the nonpregnant population, during pregnancy, the risk for GDM is likely to have a U-shape, with excess disease developing in women whose own birth weights were either very high or very low.

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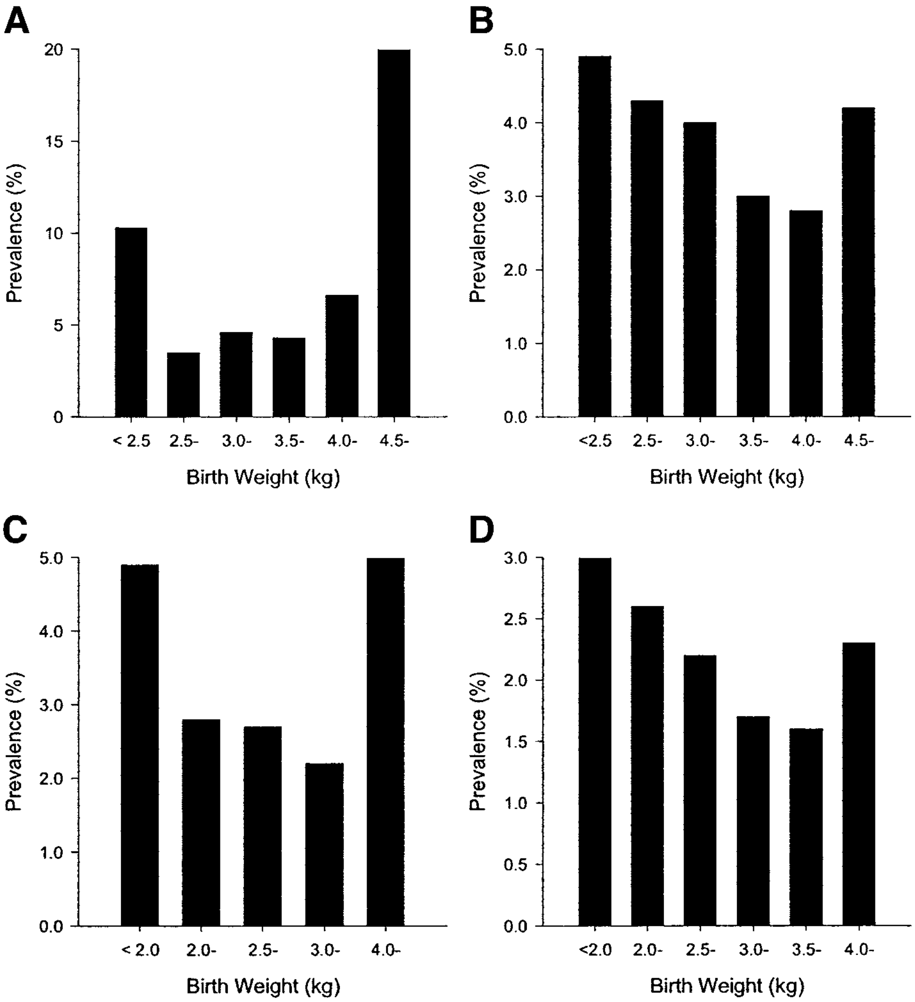

Figure l—*Prevalence of GDM in women according to their birth weight (note varying scales on both axes).* A: *Pima Indians (data from Pettitt and Knowler [14]);* B: *Norwegian women (data from Egeland et al. [16]);* C: *African-American women (data from Williams et al. [15]);* D: *women from New York State (data from Innes et al. [17]).*

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